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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 500

Contribution from Office of Farm Management
W. J. SPILLMAN, Chief

Washington, D. C. ▼ March 14, 1917

THE COST OF PRODUCING APPLES IN WESTERN COLORADO

A DETAILED STUDY, MADE IN 1914–15, OF THE CURRENT COST FACTORS INVOLVED IN THE MAINTENANCE OF ORCHARDS AND THE HANDLING OF THE CROP ON 125 FARMS IN THE FRUIT REGIONS OF MESA, DELTA, AND MONTROSE COUNTIES

By

S. M. THOMSON, Scientific Assistant, and
G. H. MILLER, Assistant Agriculturist

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A Detailed Study, Made in 1914-15, of the Current Cost Factors Involved in the Maintenance of Orchards and the Handling of the Crop on 125 Farms in the Fruit Region of Mesa, Delta, and Montrose Counties.

By S. M. THOMSON, *Scientific Assistant*, and G. H. MILLER, *Assistant Agriculturist*.

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The study of apple production discussed in this bulletin was made during the years 1914 and 1915 in the Grand Valley and adjacent districts of western Colorado.[1] This area was chosen as being representative of a region which is not only of great present commercial importance, but has a large acreage of young orchards not yet in bearing.

The Grand Valley district (see fig. 1) is primarily one of specialized fruit farming; in Delta and Montrose counties, also covered by the survey, the farming is more or less diversified. The region as a whole is one of the important centers of box-apple production, competing with the orchards of the Middle West and supplying a large part of the fruit which goes to the Texas trade. All apples are grown under irrigation, principally on comparatively small farms.

[1] This is the second of a series of bulletins designed to give comparative and comprehensive information on the different methods of orchard management in vogue in different apple-growing districts and in regard to the several factors which enter into the cost of apple production. The first of these bulletins, dealing with Wenatchee Valley, has been published as Department Bulletin 446.

NOTE.—Acknowledgments are due to the Office of Pomological and Horticultural Investigations of the Bureau of Plant Industry for material assistance rendered in the prepararion of this bulletin.

The data here presented were obtained through detailed studies of the orchard practices of 125 representative apple growers, 49 of whom were located in Mesa County, 61 in Delta County, and 15 in

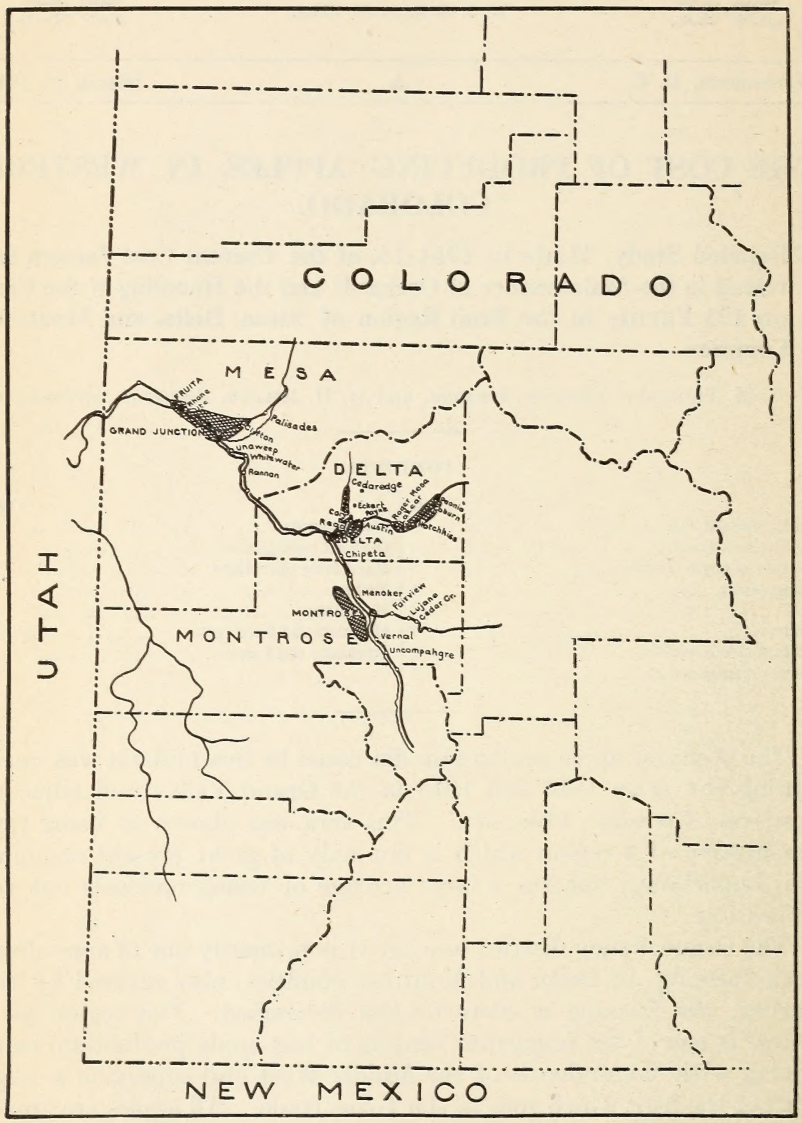

FIG. 1.—Map showing location of the western Colorado fruit districts (shaded areas) where the investigation was conducted.

Montrose County. Orchards were chosen with a view to getting a representative average, extremes in size being avoided and effort being made to pick only such as were fairly comparable in acreage and development. Data were secured from each grower as to the

time required for each operation, as to equipment, cost of labor, spraying materials, boxes, etc., and as to land and orchard values.[1]

The factors considered in arriving at the annual cost of apple production have been classified as follows:

Labor.		Costs other than labor.	
Maintenance.	Handling.	Material costs.	Fixed costs.
Manuring. Pruning. Disposing of brush. Plowing. Cultivating. Irrigating. Thinning. Spraying. Miscellaneous.	Hauling box shooks. Making boxes. Hauling loose boxes out. Picking. Hauling full boxes in. Sorting. Packing. Nailing. Other packing labor. Haul to station.	Box shook. Nails. Paper. Labels. Spray materials. Manure. Gasoline, oil, etc.	Taxes. Insurance. Water rent. Equipment charge. Machine hire. Interest. Building charge.

FACTS BROUGHT OUT.

It was found that the total cost of production[2] for the 125 farms representing the entire region averages $0.844 per box; for Mesa County (Grand Valley), $0.935; for Delta County, $0.795; for Montrose County, $0.767. (See Table I.)

Labor costs average $0.394 per box and $111.88 per acre (46.7 per cent of total cost).

Material and fixed costs (manure, spray materials, boxes, water rent, interest on investment, taxes, insurance, etc.) average $0.45 per box and $127.91 per acre (53.3 per cent of total cost). Of this cost the principal item is interest on investment in orchard, which is $0.184 per box, or 21.8 per cent of the total cost.

[1] It is of vital importance that the method of computation used in this study be fully understood at the outset; otherwise confusion and misapprehension will be inevitable. It should be borne in mind constantly that the primary result desired is a figure representing fairly the average regional cost of apple production—that is, the cost in its relation to the apple business of western Colorado as a whole. To get such an average it is often necessary to use certain averages which in themselves have no agricultural significance, which have no weight except as they contribute to the determination of the regional average. For example, the average acre cost of manuring for the entire acreage of the district under consideration is represented by a figure too small to have significance as applied to any one ranch, since not all the ranches practice manuring, but which has an economic significance with reference to the business of the district as a whole. For the purposes of this study it is as though the entire region were one farm and the cost per acre for manuring were distributed equally over the whole farm acreage rather than over the particular part of the farm upon which the manure happens to be applied. This method gives an average that may mean nothing as applied to the single operation of manuring, but which may mean much as applied to the business of growing apples in the region studied. To arrive at the result desired in this study, namely, the cost of producing apples as borne by the district as a whole, each orchard operation has been figured against the total number of farms. In this way a regional acre charge is determined for each operation, the acre being used as the unit, so that each orchard, regardless of size, may have the same weight in the final calculation. Thus, so far as these calculations are concerned, each of the 125 orchards involved may be considered as being but one acre in extent. In this way weighted averages are avoided, and the final average cost per box becomes a fairly accurate approximation of the actual cost of producing apples in the region, as represented by the 125 ranches chosen as typical of western Colorado conditions.

It was thought advisable in this connection to figure separately the costs for each county, as well as for the whole region, as the three districts differ greatly in the factors materially affecting cost. Thus the figures may be compared and the results studied in their bearing upon types and systems of farming, which differ quite widely in the three counties.

[2] Not including orchard depreciation and cost of smudging, omitted for lack of sufficient data.

The average yield for the district is 284 boxes per acre; 3.8 per tree. Average yield in Grand Valley, 275 boxes per acre; in Delta County, 294; in Montrose County, 272.

TABLE I.—*Summary of all costs entering into the annual cost of production of apples (125 ranches, western Colorado).*

	Maintenance cost.			Handling cost.			Material costs.			Fixed costs.			Total costs.		
	Per acre.	Per box.	Per cent of total.	Per acre.	Per box.	Per cent of total.	Per acre.	Per box.	Per cent of total.	Per acre.	Per box.	Per cent of total.	Per acre.	Per box.	Per cent of total.
Mesa	67.77	0.247	26.4	48.24	0.176	18.82	58.25	0.212	22.67	82.51	0.300	32.09	256.77	0.935	100
Delta	50.57	.171	21.5	59.42	.202	25.41	56.14	.191	24.02	67.83	.231	29.06	233.96	.795	100
Montrose	47.64	.176	22.9	58.66	.216	28.16	50.78	.187	24.38	51.27	.188	24.51	208.35	.767	100
District	56.94	.201	23.8	54.94	.193	22.87	56.32	.198	23.46	71.59	.252	29.85	239.79	.844	100

The trees in orchards studied average 17 years of age and 74 to the acre.

Jonathan is the leading variety, with Ben Davis, Rome Beauty, Gano, and Winesap following, each of about equal importance.

CONCLUSIONS DRAWN.

Averages secured in this study seem to warrant the following conclusions as to fruit farming in the Grand Valley and adjacent districts:

The majority of farms are not sufficiently diversified to secure the best results.

The farms studied were prosperous in direct proportion to the degree of diversification practiced.

Care must be taken in setting orchards to pick suitable soil and an area well drained and not subject to seepage.

Clean cultivation can not be practiced indefinitely without depleting the soil seriously. Humus should be supplied either in the form of manure or by using cover crops.

Manure is of very great value as an orchard fertilizer.

In general it seems inevitable that fruit growers must find important supplemental sources of income to tide them over years of low fruit prices. This is a rich country, with the advantage of a delightful climate, a naturally fertile soil, and an excellent class of progressive settlers, and it is capable of becoming a region of well-established general farming. Certain limited areas of the region are particularly well adapted to fruit growing; for example, the fruit ridges about Grand Junction and some of the mesa land in Delta County not subject to frost. Much of the region is not adapted to specialized fruit farming, and it is probable that fruit growing combined with general farming will be more successful financially than fruit growing alone.

HISTORY OF APPLE INDUSTRY.

In Mesa County the Indians occupied the Grand Valley until 1880, when they were moved into Utah. The history of fruit growing in western Colorado begins about this time. In the spring of 1883 several thousand root grafts were put out in the Grand Valley on some leased land by a Denver nurseryman, but only a fraction of the original root grafts were saved when later a more favorable location was selected for the nursery.

The first trees were set on Oldham bottoms and the lower lands of the valley. The first fruit on Fruit Ridge was set in 1885 and 1886. The plantings gradually extended from here down the valley to Fruita, but it was not until the early nineties that fruit began to be set at all extensively. By about 1900 the industry became extremely popular and land began to rise very rapidly in price. In 1900 the price of land in Grand Valley under good water rights ranged from $200 to $300 per acre. In 1907 and 1908, when prices reached their maximum, land sold from $600 to $700 per acre, while good apple orchards often sold for $1,000 or more per acre. During the period of 1900 to 1910 settlers from the Middle West and East came to the Grand Valley in great numbers. In more recent years, however, the influx has not been so great.

The history of the apple industry of Delta County is more or less correlated with that of Mesa. The first fruit of Delta County was set out about 1882, when a grower at Paonia procured 26 trees of mixed varieties from Rochester, N. Y., at $1 each. Of these 3 survived shipment. A few other pioneers began to plant trees about this time or shortly after. The industry developed rapidly in this county but on a somewhat less speculative basis than in the Grand Valley.

In Montrose County, where farming is of a comparatively general type, the fruit industry dates from about 1882. Many orchards were set in the early nineties on Spring Creek Mesa and the plantings continued until about 1909 or 1910. This region developed on a basis different from that of the apple regions of the other two counties in that fruit did not occupy so large an area of each farm and hence in years of low fruit prices did not suffer from lack of diversification in farm business.

TOPOGRAPHY.

The part of Mesa County considered in this survey, or the region known as the Grand Valley, has been carved out of a high plateau region of sedimentary rocks. The surface of the valley varies, but in the valley proper it is fairly level, requiring comparatively little labor for irrigation. (See Pl. I.)

The fruit of Delta County is located on many mesas and small districts which differ greatly in their facilities for irrigation. Most

of the fruit, however, is on level mesa areas, varying in size from several thousand acres to a few hundred. (See Pl. II.) The fruit of Montrose County is also on mesa lands easy to irrigate.

SOILS.[1]

Most of the orchards of Grand Valley are located on the Billings fine sandy loam. This is a light-gray to brown soil, easily cultivated when moist, but when dry tending to bake and hard to restore to good tilth. This is the principal soil on which fruit and other crops are grown from Palisades to Fruita. In general its drainage is good, but owing to the use of an excess of water, seepage has occurred in many places.

In the immediate vicinity of Fruitvale Station and in rather large areas near the lower levels above the river soils is found the Billings silt loam type, a heavy, sticky, and plastic soil underlain by clay or clay loam. Much of this type has gone to seep and is no longer under cultivation. It is not well adapted to fruit.

The Billings clay loam, a plastic, compact loam, varying from light gray to dark brown in color and very difficult to cultivate when dry, occurs principally in a few areas between Grand Junction and Fruita. Much of it has been affected with alkali. It seems particularly adapted to alfalfa.

The Mesa fine sandy loam, a light and easily cultivated soil requiring considerable water for irrigation, makes up a large part of the soil of the valley, especially that reached by the recently opened Highline Canal. On account of its general high-lying position and its leaching qualities it is well drained. It is adapted to fruit and other crops.

The Mesa clay loam, a reddish to chocolate-brown loam rather difficult of cultivation, is a productive soil adapted to fruit lying principally along the south side of the Grand River. This is the soil of the large mesa known as Orchard Mesa.

The Fruita fine sandy loam is a good fruit soil, but has very poor drainage, so that many of the orchards about Fruita have died from the effect of excessive alkali.

Generally speaking, the soils on which most of the thrifty apple orchards of Grand Valley are located are the Billings and Mesa fine sandy loams. The Mesa clay loam on Orchard Mesa is one of the best of fruit soils.

Nearly all the orchard lands of Delta and Montrose counties are located on Mesa clay loam. In most cases there is enough slope to prevent danger from the rise of alkali. This type of soil is well adapted to alfalfa, wheat, oats, sugar beets, and fruit. No soil

[1] Soil survey of Grand Junction area, J. G. Holmes and T. D. Rice; soil survey of The Uncompahgre Valley area, J. W. Nelson and L. A. Kolbe.

survey has been made of the Paonia and Hotchkiss districts, but the fruit here is located on mesa lands with soil of the same general type as the Mesa clay loam.

CLIMATE.

The climate of this region on the whole is semiarid, with marked seasonal ranges in temperature and great variation in season, due largely to altitude, which ranges from 4,575 feet above sea level at Grand Junction to 6,100 feet at Cedaredge, in Delta County.

The maximum precipitation is about 11 inches; minimum, 6 inches. This amount of precipitation supports only sparse native vegetation. Crops depend entirely on irrigation. An admirable feature of the climate is its very low humidity. Destructive windstorms are uncommon, but the more elevated regions are subject to destructive local hailstorms.

The topographical features of the region have a marked influence upon the occurrence of killing frosts. Often a difference in elevation of 100 feet or even less is enough to save an orchard from frost. Air currents and "pockets" also have a decided influence. Certain small areas are nearly always subject to damage by frosts. In locating an orchard it is well to pay particular attention to records of frost damage in previous years.

Table II shows climatic data for this region as compared with other important apple districts of the United States. It should be stated in this connection that the weather stations for these various places often are not located in the same locality, or on the same elevation as the orchard; hence the figures are not necessarily a true guide to weather conditions affecting the orchards.

TABLE II.—*Climate of western Colorado and other apple districts of the United States.*[1]

Station.	Altitude.	Mean annual rainfall (normal).	Mean annual temperature (normal).	Number of clear days.	Number of rainy days.	Average date of last killing frost in spring.	Average date of first killing frost in autumn.	Average number of growing days.
Western Colorado:	*Feet.*	*Inches.*	°*F.*					
Grand Junction	4,602	8.3	52.5	170	84	Apr. 18	Oct. 18	188
Fruita	4,510	10.22	49.7	182	63	May 3	Oct. 4	154
Delta	4,965	7.76	49.7	225	54	May 11	Sept. 27	139
Paonia	5,694	13.22	49.6	130	81	May 1	Oct. 10	162
Montrose	5,811	9.58	47.5	168	86	May 21	Sept. 28	130
Other important apple districts in United States:								
North Yakima, Wash.[2]	1,070	6.64	51	189.8	56.6	Apr. 18	Oct. 22	187
Payette, Idaho	2,159	11.41	50.8	168	63	May 9	Sept. 30	144
Hood River, Oreg	300	34.65	50.1	161	90	Apr. 22	Oct. 14	175
Medford, Oreg	1,425	14.57	54.5	160	114	Apr. 30	Oct. 6	159
Watsonville, Cal	23	23.85	57.3	139	80	Mar. 17	Nov. 1	229
St. Joseph, Mo	967	33.21	54.7	159	87	Apr. 17	Sept. 26	162
Brockport, N. Y	537	35.44	47.2	115	143	May 2	Oct. 13	164

[1] Taken from U. S. climatology records for past 15 years.
[2] North Yakima data taken for years 1910 to 1914 inclusive.

DISTANCE FROM MARKET.

The Grand Valley is a long distance from market. This, coupled with the fact that fruit products are perishable, makes the marketing question one of prime importance here. In the early years of the industry, when the tonnage of fruit was light and the prices high, the cost of marketing was given little thought. Orchards were set out with slight regard to distance from railroad, for as long as such high prices prevailed the growers could afford to pay hauling charges and high freight and express rates. However, with prices received of late years the cost of putting the apples into the consumers' hands in some cases has been greater than the total returns.

Formerly the mines at Aspen and other mining towns paid high prices for all fruit, both boxed and culled, and Colorado boxed apples

FIG. 2.—A comparatively inexpensive but comfortable home of a fruit rancher located on one of the mesa lands in Delta County.

brought big returns in city markets, Colorado Springs and Denver then being the principal cities of importance in which the fruit was marketed. Now, however, the disadvantage under which the region labors as regards distance from market is being felt, and adjustments in farm practice have been found necessary. Such adjustments are now going forward.

FARM ORGANIZATION.

RELATION OF ORCHARD TO FARM ORGANIZATION.

Even in specialized apple districts there are few farms or ranches where bearing apples are the only source of income, and where the cost of producing apples is the cost of operating the farm. Most growers have, besides a bearing apple orchard, a considerable acreage of other orchard, usually young apples, or it may be peaches or pears. Still others grow some alfalfa to sell and, in Montrose County particularly, considerable quantities of grain and potatoes are grown

A TYPICAL LANDSCAPE VIEW OF THE GRAND VALLEY, SHOWING ORCHARDS IN THE CLIFTON DISTRICT AND IN THE DISTANCE THE RANGE WHICH PROTECTS THE UPPER GRAND VALLEY FROM FROSTS.

Note the sharp contrast between desert and cultivated land.

LOOKING OVER THE INTENSIVE FRUIT DISTRICT ON THE MESA LANDS BETWEEN CORY AND AUSTIN, IN DELTA COUNTY.

for sale. In the case of a young orchard the expense necessary to keeping it up is, of course, chargeable to the young orchard and does not enter into the cost of production of apples from a bearing block.

On the farms situated in Mesa County there is an average of 3.5 acres of young apples per ranch as compared to 8.22 acres of bearing apples; in Delta, 4.94 acres young and 12.19 bearing, and in Montrose, 3.56 young and 13.66 bearing. Furthermore, but 42 per cent of the farm acreage of the ranches surveyed in the Grand Valley is in bearing apples, 23.5 per cent in Delta, and 31 per cent in Montrose. Ninety-two per cent of the total area of the ranches surveyed in Mesa is tillable, 73 per cent in Delta, and 90 per cent in Montrose. A few farms were found where the cost of operating the farm was the same as the cost of producing the apples from the bearing block. In such cases all labor, both man and horse, is charged to the orchard.

Under such specialized conditions there are always long periods of enforced idleness for horse labor and often for man labor, espe-

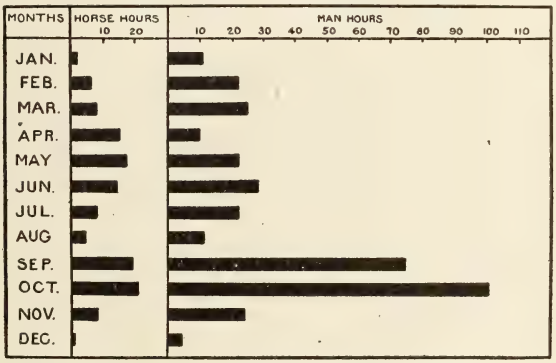

FIG. 3.—Chart showing the average distribution of man and horse labor on an acre of bearing orchard throughout the year.

cially where help is hired by the month. By growing alfalfa or annual crops adapted to the region, together with hogs or poultry, a more profitable distribution of labor may be secured.

SIZE AND TYPE OF FARM.

Table III shows the average size, tillable area, and orchard acreage of the farms studied. The fact that these farms in most cases are small is principally due to the system of land development. In many cases land was bought up, set to fruit, and held for speculation at prices such that the average investor desiring a home could not afford to buy many acres. In fact, it was believed more desirable to have a small, intensive, specialized farm than a larger and more diversified one. In days of high fruit prices this belief was justifiable for the time being, but no provision was made for the day of low fruit prices.

TABLE III.—*Average size of farms and orchards (125 ranches, western Colorado).*

	Mesa.	Delta.	Montrose	All counties.
Number of records	49	61	15	125
Average acreage of farms	19.56	51.86	43.86	38.24
Tillable acres per farm	18	37.34	39.47	30.01
Per cent of farm area tillable	92	72	90	78.4
Average acreage of bearing orchards	8.22	12.19	13.66	10.81
Average acreage of young apple orchards	3.5	4.94	3.56	4.21
Per cent of farm area in bearing apple orchards	42	23.5	31	28.3

The farms are most highly specialized in Mesa, less so in Delta, and least in Montrose. Crops besides tree fruits grown for sale include a few truck crops, small fruits, potatoes, alfalfa, small quantities of alfalfa seed, and a little grain. Potatoes are a very important crop in Montrose and parts of Delta County. Most of the grain grown for sale comes from Montrose. Very little stock is kept on the farms surveyed, although on many of the larger ranches of the region stock is fed during the winter and the manure returned to the land. Mesa County (Grand Valley) is very highly specialized, and devoted almost exclusively to fruit, differing in this respect from the other two counties.

INVESTMENTS.

The amount of capital invested in the fruit farming of western Colorado as compared to other types of farming is very great. The average total investment of the 49 farms in the Grand Valley, averaging 19.56 acres in size, is $12,004.02; the average total investment per acre of these farms, giving each farm the same weight, is $778.32. On these same farms the average bearing apple-orchard investment per farm is $5,826.04, and the average acreage of apples 8.22 acres, or 42 per cent of the average total farm area. However, the average investment per acre on these orchards, giving each orchard, large or small the same weight, is $751.56. The interest charge per acre is figured on this average. (See Table IV.)

The equipment investment per farm as shown in Table IV includes no stock, either horses or cattle, but includes all machinery and other equipment necessary. For the size of farm this is a high investment, due largely to the diversity of tools that are found on these ranches.

TABLE IV.—*Farm and orchard investments (125 ranches, western Colorado).*

	Mesa.	Delta.	Montrose.	All counties.
Investment per farm:				
Total	$12,004.02	$19,781.23	$16,733.78	$16,366.87
In land and improvements	11,861.98	18,238.79	14,914.28	15,340.14
In bearing apple orchard	5,826.04	7,414.74	6,292.85	6,657.34
In equipment	751.56	627.38	439.28	653.49
Investment in bearing apple orchard per acre:				
Total	603.02	719.37	1,008.92	708.51
In equipment	36.00	24.00	31.16	29.56
Per cent of farm investment in bearing apple orchard:				
Total	48.5	37.48	37.6	40.7
Land and buildings	49.11	40.6	42.19	43.4

Even assuming that the buyer of a ranch has paid down the entire cost price and has his ranch clear, he is not yet safely established, for he needs in addition a considerable working capital in order to buy the necessary equipment and keep it in repair. This accounts for the fact that in some cases where ranches were entirely free of debt owners have been obliged, by reason of lack of working capital and a series of unfavorable seasons, to mortgage their ranches and eventually lose them.

Table V shows the per cent of interest realized on investment per box at various prices for fruit. Figured on a basis of average annual yield per acre, the apple-land investment per box is $2.73 for Mesa, $2.13 for Delta, and $1.62 for Montrose, or $2.30 per box for all orchards. The annual cost of production per box minus the interest charge on apple land for these counties respectively is $0.716, $0.624, and $0.637, or for all counties it is practically $0.66 per box. It is seen that with fruit at $0.50 a box the grower on the farms studied in the Grand Valley loses 7.9 per cent on his investment, or for all counties he loses 6.95 per cent. If fruit brings $0.90 a box, he makes 6.73 per cent in the Grand Valley, or 10.44 per cent for all counties. When all counties are considered he must get $0.844 per box in order to make 8 per cent interest on his investment. When all grades of box apples are considered it is seldom of late years that a grower receives a price of $1 per box f. o. b. on his apples, and the average is usually considerably less.

TABLE V.—*Per cent of interest the average grower realizes on his investment in bearing apple orchard (125 ranches, western Colorado).*

Price per box, f. o. b.	Per cent of interest realized on investment.			
	Mesa.	Delta.	Montrose.	All counties.
$0.50	− 7.92	− 5.83	− 8.51	− 6.95
.60	− 4.26	− 1.14	− 2.33	− 2.60
.75	+ 1.23	+ 5.91	+ 6.93	+ 3.92
.90	+ 6.73	+12.95	+16.19	+10.44
1.00	+10.39	+17.64	+22.36	+14.78
1.25	+19.55	+29.38	+37.79	+25.66

LABOR.

The growers of Grand Valley depend principally on day labor for help. In Delta and Montrose Counties considerable month labor is hired. The average price paid for month labor varies from $30 to $60 per month, depending on the privileges the laborer receives. In all three counties, up to 1915, the average day-labor rate for orchard work, except pruning, was 25 cents per hour. Pruning was 35 cents per hour. Work done by the farmer or any of his family is counted at

the current rate. Labor conditions are as good as can be expected. There is seldom a great scarcity of help.

Horse labor is charged at a nominal rate of 15 cents per hour. On many of these ranches two horses are kept in comparative idleness throughout the year, except during harvesting, spraying, hauling brush, and spring cultivating. Although hay is cheap and little grain is fed, it costs fully 15 cents per hour for productive horse labor.

The labor on apples is unevenly distributed. It reaches its highest point at harvesting time and during thinning in the latter part of June, when there is also a certain amount of cultivating and spraying to be done. It is high in March, as much of the pruning and removing of brush from the orchard is done during that month. If the labor curve for the few men who smudge were shown it would be high in April and May, but considering the general practice the curve is low in April. The accompanying labor chart (fig. 3) shows the approximate annual distribution of labor on an acre of bearing orchard (125 records).

THE ORCHARDS.

LOCATION.

The fruit district known as the Grand Valley is situated in Mesa County, of which Grand Junction is the county seat. Locally the Grand Valley district is divided into four different districts, known as the Palisade district, the Clifton district, the Grand Junction district, and the Fruita district. These districts all merge into each other, but have more or less distinctive features. The principal fruiting section of the Grand Valley is about 30 miles in length. The oldest, largest, and most famous district is that about Grand Junction. Here nearly all peach orchards have been or are being eradicated. In the Clifton district are found about as many pears as apples, and there is no doubt that the soils about Clifton are well suited to the growing of pears. The Palisade district is primarily devoted to peaches. In the Fruita district, which has now lost much of its commercial importance, apples come first, with a few pears and practically no peaches.

In the Grand Valley the fruit is not located on mesa lands, except on Orchard Mesa, across the river from Grand Junction. Most of the fruit is in the main river valley, but lies back some distance from the river, owing to the lands first settled next to the river having gone to seep.

In Delta County the fruit occupies a much more scattered area. The fruit in this county is located from Delta to Paonia in the valley of the Gunnison and the North Fork of the Gunnison. The bearing apple orchards are found principally about the towns of Austin, Cedaredge, Hotchkiss, and Paonia. With few exceptions these orchards are located on mesa lands.

In Montrose County the orchards are practically all on the mesa lands, the most important of which is Spring Creek Mesa. Ash and California Mesa also have a small amount of fruit.

SIZE OF ORCHARDS.

The size of the bearing orchards found on farms varies greatly, the extremes of the records in Mesa being 2 and 27 acres, the majority being between 5 and 10 acres. In Delta the variation was from 3 to 45 acres, the majority being between 6 and 15 acres, and in Montrose from 5 to 40 acres, and an average of between 10 and 15

FIG. 4.—A 15-year-old Ben Davis orchard in full bearing located on Spring Creek Mesa, Montrose County. Note the vigorous growth of these trees which have been heavily manured. This orchard has always been clean cultivated.

acres. Of young apple trees there was an average acreage per farm of 3.5, 4.94, and 3.56 acres, respectively, in Mesa, Delta, and Montrose Counties.

AGE OF ORCHARDS.

The orchards from which records were taken were fairly uniform in age, averaging 17½ years in Mesa, 17 in Delta, and 16½ in Montrose. Practically all were between the ages of 12 and 20 years. There are, however, many orchards older than 20 years, but these are not the commercial orchards and are usually of small acreage. At the time of this investigation there were practically none over 30 years of age.

VARIETIES.

A great number of varieties of apples are found in this region. In the old orchards there are varieties of every season and often not enough of any one to market in commercial quantities. In the orchards over 20 years of age one often finds over 10 or 12 varieties, and one grower in Delta claimed 161 distinct varieties. This, of course, is an exception. Usually these early orchards were set out for family use; hence the great number of varieties of different seasons of ripening.

For the most part the apples which were considered of commercial importance 20 years ago, such as Baldwin, Ralls, Willowtwig, Smith Cider, Lawver, Missouri, Ben Davis, and others, are not considered as such to-day. Ben Davis, however, still is one of the leading commercial varieties, though it is seldom found in the young orchards.

The variety of greatest commercial importance here is the Jonathan. In the bearing orchards studied this is followed by Ben Davis, but in the young orchards and those coming into bearing it is followed by Winesap, Gano, and Rome Beauty, each of about equal importance. Other varieties of considerable commercial importance are Missouri, Arkansas (Mammoth Black Twig), Arkansas Black, White Pearmain, and Grimes. The younger plantings are made up of varieties now regarded as commercial, such as Jonathan, Winesap, Gano, Rome Beauty, Grimes, Wealthy, and a few Delicious and Banana.

NUMBER OF TREES PER ACRE.

There is an average of 70 trees per acre in the bearing orchards of Mesa County, 78 trees per acre in Delta County, and 71 trees per acre in Montrose. The trees per acre in Mesa range from 42 to 125, in Delta from 40 to 133, and in Montrose from 39 to 100. This wide variation is due to the method used in setting. On the farms studied in Mesa County there were 8 orchards set 20 by 20 and 7 set 30 by 30 on the square. Several used the diagonal or quincunx system of setting. In Delta and Montrose there was fully as much variation, some old orchards on the lowlands being set as close as 15 by 15. However, the method more generally in use now is the diagonal plan. Most of the younger orchards are now set 28 by 28 or 30 by 30 on the diagonal.

ORCHARD MANAGEMENT PRACTICE.

Under orchard practice is included manuring, pruning, hauling and burning brush, plowing and all cultivating operations, irrigating, thinning, putting on and tending codling-moth bands, spraying, scraping trees, harvesting labor, including all labor used in handling the crop from the time it is picked from the trees until delivered at the warehouse or station, and certain minor items classed as "miscellaneous."

MANURING.

In the Grand Valley the application of manure on orchards is not a general practice. The ranchers of this vicinity keep but a small amount of stock and thus little manure is produced on the farm. Sixteen of the 49 growers visited in Mesa County, or 32.6 per cent, make a practice of manuring all or part of their orchard each year. The labor cost per acre is $2.04 and the material cost $3.57. In Delta County a large proportion of the growers apply manure, owing to the fact that Delta is a more general farming county than Mesa, and the average number of animals units per farm is larger. Thirty-one (50.8 per cent) of the 61 men visited in this county apply manure. Here the cost of labor per acre is $2.62; of material, $6.38. In Montrose County the type of farming is still more general, and more stock is kept; hence a still greater percentage of growers apply manure. Ten of the 15 men visited in Montrose, or 66 per cent, practice manuring, at a cost of $4.28 per acre for labor and $6.35 for material (see fig. 4).

For the three counties there is an average annual acre charge of 10.62 man-hours and 20.20 horse-hours, and an average application of 7.71 tons per acre, for the 57 men (45.6 per cent) who practice manuring.

It should be explained in this connection that the manure applied per man-hour appears low because of the fact that there is but little manure, which usually is drawn out in very small loads and applied only where most needed. Thus, these figures would not be applicable to conditions in which plenty of manure is available. (See Table VI.)

Commercial fertilizers are not used in this region.

TABLE VI.—*Manuring practice and costs for farms studied.*

Item.	Mesa.	Delta.	Montrose.	All counties.
Farms applying manure:				
Number	16	31	10	57
Per cent of all farms	32.6	50.8	66.7	45.6
Averages per acre for farms applying manure:				
Man-hours	11.36	9.9	11.66	10.62
Horse-hours	22.72	17.9	23.32	20.20
Tons of manure	7.28	8.37	6.35	7.71
Cost of labor	$6.25	$5.16	$6.41	$5.69
Cost of material	$10 92	$12.56	$9.53	$11.56
Averages per acre, distributed over all farms studied:				
Man-hours	3.71	6.03	7.77	4.84
Horse-hours	7.42	9.10	15.55	9.21
Tons of manure	2.38	4.25	4.23	3.51
Cost of labor	$2.04	$2.62	$4.28	$2.59
Cost of material	$3.57	$6.38	$6.35	$5.27
Total cost	$5.61	$9.00	$10.62	$7.86

PRUNING.

Pruning is an operation practiced every year by all growers. It is done during the winter or dormant season. Hired help is usually paid more than the regular rate for pruning, as this operation requires skill. If a grower prunes for another he usually values his time at 35 cents per hour, so in pruning this rate is used.

In Mesa County the 49 growers prune an average of 11.18 trees in 10 hours, which, with an average of 70 trees per acre in the county, amounts to 62.61 man-hours per acre, which, figured at 35 cents per hour, makes an average annual acre charge of $21.91. The trees in Mesa average 17 years in age. (See Table VII.)

In Delta County less time is given to pruning than in Mesa. The 61 growers in this county prune an average of 16.34 trees in 10 hours, which makes the annual acre charge $16.71. The trees average 17½ years in age.

In Montrose County the time required is slightly greater than in Delta County, one man pruning 14.61 trees in 10 hours, at a cost of $17.01 per acre. The trees average 16½ years in age.

If the pruning costs of the 125 records are combined, it is found that with an average of 74 trees per acre one man will prune 14.11 trees in 10 hours, or spend 53.67 hours per acre, or a cost of $18.78 per acre on 17-year-old trees, making an annual charge of $0.254 per tree for pruning.

The orchards surveyed in these three counties were of such uniform age that the difference between individual records depends more on the individual growers' system of pruning than any difference in age of orchards. Varieties and methods of pruning influence the cost. For instance, the cost of pruning Winesap or Arkansas Black is more than that of pruning Ben Davis or Gano.

The systems of pruning are many, but the general method is to prune for an open head and a low tree, with plenty of fruiting surface. Much of the pruning is done by means of pruning shears, since on account of the regular pruning which the orchard receives there are not many large limbs to cut.

TABLE VII.—*Labor costs for pruning (125 ranches, western Colorado).*

Item.	Mesa.	Delta.	Montrose.	All counties.
Number of estimates	49	61	15	125
Number of trees per acre	70	78	71	74
Age of trees	17	17½	16½	17
Number of trees pruned in 10 hours	11.18	16.34	14.61	14.11
Man-hours per acre	62.61	47.73	48.59	53.67
Cost per acre	$21.91	$16.71	$17.01	$18.78

HAULING AND BURNING BRUSH.

The cost of picking up, hauling, and burning or getting rid of the brush from the orchard varies greatly, according to the facilities for handling it. In the three counties the usual method is to pick, haul, and burn at the same time. In Mesa County 22 growers use a 1-man 2-horse crew, 22 use a 2-man 2-horse crew, and 5 use a combination of crews and methods. It is found that here the 1-man 2-horse crew, with a total cost of $4.11 per acre, is slightly more efficient than the 2-man 2-horse crew, which costs $4.82 per acre. There were not enough records of other combinations to justify conclusions. In Delta County 19 men used a 1–2 crew, 37 a 2–2 crew, and 5 other methods. Here the 2–2 crew was not nearly so efficient as the 1–2 crew, the former costing $4.06 per acre, as against $2.96 for the latter. In Montrose County, with four 1–2 crews and ten 2–2 crews, there is a difference in cost of $0.30 per acre in favor of the 1–2 crew on the farms studied.

The total costs for the three counties, regardless of the crews used as well as the time and cost of the three counties combined, are given in Table VIII.

TABLE VIII.—*Time and cost per acre for disposing of brush (125 ranches, western Colorado).*

Item.	Mesa.	Delta.	Montrose.	All counties.
Number of records	49	61	15	125
Number man-hours	9.75	8.46	6.43	8.72
Number of horse-hours	12.84	9.90	7.78	10.64
Cost	$4.36	$3.60	$2.77	$3.78

CULTIVATION.

Under the general heading of cultivation are grouped all the various tillage operations. These are plowing, disking, harrowing with both spike and spring tooth, floating, cultivating, and marking or creasing out the furrows for irrigation. The normal time has been obtained for these different operations and the cost per acre for each operation figured, but in the final charge the same system of distributing the cost is used as previously explained.

On account of the fact that clean cultivation is being abandoned in this region and the use of a mulch crop is coming into a more general practice, especially in Delta County, the final figures for cultivation are too low for clean-cultivated orchards. At the time of this investigation an attempt was made to separate the cultivating costs on the clean cultivation records from the costs on mulch crops or sod

orchards, but on account of the fact that the change in practice from clean cultivation to the use of a mulch crop or sod, is now in a transitory stage and has not been in practice long enough to affect yields, it was difficult in many cases to determine which orchards should be regarded as clean cultivated and which as mulch crop. Many use a thick growth of weeds for a mulch crop, and in such cases there is often considerable cultivation before the weeds are allowed to grow. (See Table IX.)

TABLE IX.—*Ranches classified by soil management (125 ranches, western Colorado).*

Soil management.	Number of ranches.			
	Mesa.	Delta.	Montrose.	All counties.
Clean cultivation	32	13	7	52
Clover	4	23	4	31
Weeds	5	11	0	16
Alfalfa	7	9	4	20
Vetch	1	.....	.....	1
Alfalfa and clover	.....	5	.....	5

Plowing is sometimes done in early spring, but most men plow in the late fall. A few, particularly in Delta County, plow the mulch crop under during the summer. By plowing in the fall, the ground is given the full benefit of the moisture of the snow which falls during the winter.

Some ranchers do not plow every year. In Mesa County, for example, 25 men plow every year, 12 plow every 2 years, 5 plow every 3 years, and 1 plows every 4 years, making a total of 43, or nearly 88 per cent, who plow. However, the percentage is reduced to 67 if figured as an annual charge against the total number of records. For Montrose this percentage is the same as for Mesa; for Delta it is 48.

The plowing cost per acre for all counties is $3.83, one man and team plowing 1.44 acres per day. There is never more than one plowing during the season, but the cultivating tools are used after each irrigation to a certain extent.

In Table X the 125 ranches are classified according to practices in cultivation.

TABLE X.—*Cultivation practices (125 ranches, western Colorado).*

	Mesa.			Delta.			Montrose.			All counties.		
	Number records.	Times over.	Per cent records.	Number records.	Times over.	Per cent records.	Number records.	Times over.	Per cent records.	Number records.	Times over.	Per cent records.
Disk	19	1.8	39	36	2	59	8	1.9	53	63	1.9	50.4
Spring-tooth	10	2	20	23	1.5	38	6	2.3	40	39	1.8	31.2
Spike-tooth	25	1.8	51	14	1.9	23	5	1.8	33	44	1.8	35.2
Cultivate	18	1.6	37	7	2.1	12	1	2	7	26	1.8	20.8
Float	35	1.2	71	19	1.2	31	8	1.6	53	62	1.3	49.6
Crease	49	1	100	61	1	100	15	1	100	125	1	100
Irrigation.												
Disk	1	2	2	11	1.9	18	5	2.4	33	17	2.1	13.6
Spring-tooth	3	1.7	6	11	1.6	18	3	1.3	20	17	1.6	13.6
Spike-tooth	8	1.3	16	3	1	5	1	2	7	12	1.3	9.6
Cultivate	27	1.9	55	9	1.8	15	1	2	7	37	1.9	29.6
Float	6	1	12				2	2	13	8	1.3	6.4
Crease	38	1	77	33	1	52	7	1	47	78	1	62.4
Irrigation.												
Disk	2	2	4	9	1.9	15	4	1.8	27	15	1.9	12
Spring-tooth	2	2	4	7	1.4	12	3	1	20	12	1.4	9.6
Spike-tooth	5	1.2	10	3	1.3	5	2	3	13	10	1.6	8
Cultivate	24	1.4	49	7	1.9	12				31	1.5	24.8
Float	3	1	6	2	1	3	3	1.7	20	8	1.3	6.4
Crease	28	1	57	22	1	35	7	1	47	57	1	45.6
Irrigation.												
Disk				2	1.5	3	3	2.3	20	5	2	4
Spring-tooth	3	1.7	6	3	1.7	5	2	1	13	8	1.5	6.4
Spike-tooth	2	1	4	2	1.5	3	2	3	13	6	1.8	4.8
Cultivate	11	1.7	22	3	1.3	5				14	1.6	11.2
Float	1	1	2	1	1	2	2	1.50	13	4	1.3	3.2
Crease	13	1	26	8	1	13	5	1	33	26	1	20.8
Irrigation.												
Disk												
Spring-tooth				1	1	2				1	1	0.8
Spike-tooth	1	1	2							1	1	0.8
Cultivate	1	2	2	1	2	2				2	2	1.6
Float												
Crease	3	1	6	2	1	3				5	1	4
Irrigation.												

Creasing is a universal practice before the first irrigation, and when there are any cultivations between irrigations the operation is repeated. The next most prevalent practice in cultivation is the use of the disk, followed by the float, spike-tooth, spring-tooth, and lastly the cultivator, in the order named. In Table X, however, the tools are named in the order in which they are used.

The disk, usually a 4-foot or 6-foot extension disk, is used quite generally on the alfalfa orchards in early spring and perhaps even after one or two irrigations. The spring-tooth is used to some extent on the sod orchards in early spring, but is largely confined to clean cultivation. Spike-tooth, float, and the cultivator are almost entirely confined to the clean-cultivation orchards. It should be explained that in creasing there are two very distinct tools used, viz, a cultivator which usually makes two or three furrows at a time and the shovel plow, which makes but one. The cultivator is the tool most commonly used, except in sod orchards, where there are many roots to contend with, where a shovel plow is usually used. In clean cultivation one horse ordinarily can handle a shovel plow, but under

the conditions which make the use of this tool desirable here, two horses are commonly used. Indeed, the two-horse team is most commonly used in all operations. More than two horses are rarely used and only a few men, owners of small orchards, use one horse.

In order to show the normals of these different operations as arrived at by the estimates of all growers who practiced them, Table XI has been prepared merely to show normal time required. It should be understood in this connection that these normal times and costs do not refer to the actual costs per record, but refer only to the actual average cost of one operation on 1 acre with a given cultivating tool. In arriving at actual costs chargeable, take Mesa County, where 39 per cent of the growers of the county practice disking before the first irrigation, and they go over the ground an average of 1.8 times; then to find the cost per record, using an acre as the unit for the county, take the normal time for that given operation, multiply it by the average number of times over, and then by the per cent of growers in the county practicing the operations, as 2.28 (normal man-hours per acre) $\times$ 1.8 (number of operations) $\times$ 0.39 (per cent of men who practice it) — number of man-hours chargeable.

Number of man-hours $\times$ man-hour rate = cost of man-labor.
Number of horse-hours $\times$ horse-hour rate = cost of horse-labor.

Normals in this table are given only for one-man two-horse crews, as the few other combinations found are not numerous enough to give a normal. Cultivating times vary somewhat, according to conditions of the soil and the season, so that in some instances more than one estimate covering cultivations between different irrigations have been used in figuring the normal. This accounts for the number of estimates being larger in some cases than the number of records.

TABLE XI.—*Normal time in cultivation (1-man, 2-horse).*

Operation.	Mesa.				Delta.			
	Number estimates.	Man-hours per acre.	Acres per day.	Cost per acre.	Number estimates.	Man-hours per acre.	Acres per day.	Cost per acre.
Plow	43	6.86	1.46	$3.77	40	7.25	1.38	$3.99
Disk	22	2.28	4.39	1.25	57	1.88	5.32	1.03
Spring-tooth	18	1.37	7.30	.75	45	1.63	6.13	.90
Spike-tooth	40	1.18	8.47	.65	22	1.28	7.81	.70
Cultivate	70	1.70	5.88	.94	27	1.69	5.92	.93
Crease	105	1.12	8.93	.62	109	1.17	8.54	.64
Shovel plow (1 man, 2-horse)	16	2.06	4.85	1.13	10	1.92	5.21	1.06
Float	43	1.33	7.50	.73	21	1.44	6.94	.79

TABLE XI.—*Normal time in cultivation (1-man, 2-horse)*—Continued.

Operation.	Montrose.				3 counties.			
	Number estimates.	Man-hours per acre.	Acres per day.	Cost per acre.	Number estimates.	Man-hours per acre.	Acres per day.	Cost per acre.
Plow	10	6.34	1.58	$3.49	93	6.97	1.44	$3.84
Disk	20	1.41	7.59	.78	99	1.87	5.35	1.03
Spring-tooth	14	1.27	7.87	.70	77	1.50	6.67	.83
Spike-tooth	10	.93	10.75	.51	72	1.18	8.47	.65
Cultivate	2	1.33	7.52	.73	99	1.69	5.92	.93
Crease	34	.85	11.76	.47	248	1.10	10.00	.61
Shovel plow (1 man, 2-horse)					26	2.01	4.98	1.11
Float	15	.93	10.80	.51	79	1.28	7.81	.70

After figuring out the costs of all cultivation, including plowing, and distributing that cost over the total number of records, there is indicated for Mesa County an average cost of $9.98 per acre as compared with $7.74 for Delta, where less clean cultivation is practiced, and $8.39 for Montrose, where more clean cultivation is practiced than in Delta but less than in Mesa. The average for the three counties is $8.70. (See Table XII.)

TABLE XII.—*Cost of cultivation on farms studied.*

Item.	Mesa.	Delta.	Montrose.	All counties.
Man-hours per acre	18.55	14.08	15.25	15.97
Horse-hours per acre	35.63	28.14	30.50	31.36
Cost per acre	$9.98	$7.74	$8.39	$8.70
Cost per box	$0.035	$0.027	$0.030	$0.030

MULCH CROPS.

The practice of using a mulch crop has a direct bearing on the extent, kind, and cost of cultivation. The term mulch cropping, in this connection, refers to the practice of growing alfalfa, clover, or any other crop in the orchard to be taken off as hay or turned under as fertilizer. Strictly speaking, in many of these cases these crops might be referred to as shade crops instead of mulch crops. The growers call them cover crops. Up to three or four years ago clean cultivation was the universal practice, and the method was more intensive than that now in vogue (see fig. 5). However, the practice of using a mulch crop has been gaining in favor very rapidly, so that in a few years it is likely that clean cultivation as a regular practice will be generally discontinued. Considerable cultivation is necessary, of course, even with a cover crop, for alfalfa is usually disked annually and clover is turned under every two or three years and the orchard cultivated for a year before it is sown again. When weeds or sweet clover are used as a mulch crop the orchard is clean cultivated during

the first part of the season and they are allowed to grow after the first or second irrigation.

As has been explained, it was impossible to separate the figures for the different kinds of soil management and have enough records of any one kind to give the figures conclusive meaning, so that all work is averaged over the total number of records.

As yet comparatively little income has been derived from hay taken from these orchards. The mulch crops have been so recently established that most growers still leave the crop on the ground after mowing. However, since the recent decline in the price of apples, growers are coming more and more to realize the necessity

FIG. 5.—A 7-year-old orchard in the Grand Valley under the intensive clean cultural system of soil management. Note how close the trees are set in the row.

of getting something more than apples from their land. Thus, in the year 1915 many men mowed their orchards and saved the hay for feed. The few men who cut orchard hay harvested 1½ to 5 tons per acre of alfalfa. Clover, less frequently taken off, averages much less per acre. The cost of harvesting this hay is about $2.50 per ton, and the local price $4 to $8, so that there is often a considerable hay credit to an orchard. In these figures, however, owing to the mulch-crop system not having been firmly established at the time the records were taken, no consideration is given to hay in the cost tables. In general, however, it may be said that a system of mulch or cover crops cropping is becoming very popular in western Colorado and intensive clean cultivation in the bearing orchards has but few advocates (see figs. 6 and 7).

IRRIGATION.

The cost of irrigation depends on method, quantity of water available, rate of flow, topography, condition of the soil, length of furrows,

FIG. 6.—A 22 year-old Grimes orchard located on sandy soil in the river bottom section near Paonia. The clover in this orchard acts as a shade crop and is sometimes turned under but never taken off.

FIG. 7.—A 7-year-old orchard in the Grand Valley showing the clover shade crop between rows.

width of furrows, and the time of year. The usual method of irrigation is by open ditches. The water is carried from the main ditch to the ranches in smaller open ditches, known as laterals. From

them it is delivered to the orchards by means of open ditches, wooden flumes, or pipes. Piping is the quickest and most convenient method, but this system, because of the great initial expense, is not generally used.

In the Grand Valley (Mesa County) the majority of the growers water their orchards from the Grand Valley Canal at a cost of 88 cents per acre per annum. Water from the Price ditch costs per year about $4 per acre. The growers interviewed on orchard mesa have to pay much more per acre for their water, which is pumped. Along the Grand River and canal are a number of water wheels that raise water for small tracts. (See fig. 8.) This river is the source of all water used for irrigation on the farms studied in Mesa County.

FIG. 8.—Method of raising water to irrigate lands above the Grand Valley canal near Grand Junction.

In Delta County the sources of irrigation are the Gunnison and Uncompahgre Rivers and Surface and Forked Tongue Creeks. The water for the Paonia and Hotchkiss district is largely from the North Fork of the Gunnison River, while the region about Austin is watered by Surface Creek. The water sells by shares at an annual assessment per share, so that there is no fixed acre charge for water rent.

In Montrose County the water for Spring Creek Mesa is taken from the Government project canal, which was completed in 1910 and absorbed the canals of the old Uncompahgre Ditch & Land Co. Generally speaking, there is no lack of water for irrigation purposes; indeed, water frequently has been applied too freely, as the orchardists themselves testify. In many places, especially in the Grand Valley, the ground has been so thoroughly saturated that alkali has been brought to the surface and killed hundreds of acres of formerly productive orchards.

TABLE XIII.—*Number of irrigations (125 ranches, western Colorado).*

Irrigation.	Mesa (49 farms).			Delta (61 farms).			Montrose (15 farms)			All counties (125 farms).			
	Per cent reporting.	Average time.	Time chargeable.	Per cent reporting.	Average time.	Time chargeable.	Per cent reporting.	Average time.	Time chargeable.	Number reporting.	Per cent reporting.	Average time.	Time chargeable.
		Hrs.	*Hrs.*		*Hrs.*	*Hrs.*		*Hrs.*	*Hrs.*			*Hrs.*	*Hrs.*
First	100	2.78	2.78	100	3.49	3.49	100	3.64	3.64	125	100	3.23	3.23
Second	100	2.71	2.71	100	3.41	3.41	100	3.32	3.32	125	100	3.12	3.12
Third	95.9	2.67	2.56	96.7	3.36	3.25	100	3.32	3.32	121	96.8	3.09	2.99
Fourth	87.7	2.53	2.22	85.2	3.39	2.89	66.7	2.32	1.54	105	84	2.94	2.47
Fifth	51	1.95	.99	54.1	2.98	1.61	33.3	2.02	.68	63	50.4	2.50	1.26
Sixth	18.3	1.43	.26	21.3	3.61	.77	20	2.08	.42	25	20	2.64	.53
Seventh	6.1	1.01	.06	8.2	2.79	.23	6.6	1.20	.08	9	7.2	2.02	.15

Table XIII shows that the greatest time is required for the first irrigation, with a slightly shorter time for the second and third, and that thenceforward the time decreases with each irrigation. This is due to the fact that the fifth, sixth, and seventh irrigations are performed only by those men who water their orchards lightly and often, while the first three irrigations include all who water heavily and but three times during the season. Thus it will be seen that the average time for irrigation falls off as the number of irrigations per season increase.

The number and the length of furrows naturally influence the time. Where furrows are long it takes considerable time for the water to reach the far end; furthermore, the soil tends to become oversaturated at the head of the furrow. The number of furrows varies from 3 to 8, with an average of 5, about an equal number using 4, 5, and 6 furrows. The number of furrows, of course, depends on width of row, tool used, kind of soil, and how long the water is to be left on. The farther the furrows are apart the longer the water is left on. This time varies from 12 to 72 hours, but is usually between 36 and 48 hours. The number of sets necessary depends on the quantity of water used. The usual allowance in the Grand Valley is one-half inch per acre. In the other counties this figure varies.

TABLE XIV.—*Cost summary for all irrigations (125 ranches, western Colorado).*

Per acre.	Mesa.	Delta.	Montrose.	Three counties.
Man-hours	11.59	15.66	12.99	13.74
Cost	$2.90	$3.91	$3.25	$3.44

A comparison of time required throughout the region for irrigating in sod orchards and in orchards under clean cultivation shows that under clean cultivation the time averages about one-half hour longer

per acre than on sod. This slight difference may be due to the fact that, in general, less care is taken in irrigating orchards in mulch crop, although to keep the mulch crop from clogging the furrows often entails extra work.

In Table XIV is given a cost summary for all irrigations.

THINNING.

Thinning the fruit from the trees is a practice followed by the majority of growers. This operation is usually done in June or July, most growers thinning during the latter part of June. Thinning increases the size and color of the remaining fruit, and if practiced systematically eliminates in large measure the cull or poor fruit, thus saving harvest labor. This operation is done by hand, either by picking the apples or clipping them off with a thinning shears. The low-headed trees are most frequently thinned. It is not customary to thin branches which can not be reached from a stepladder. Apples are left from 3 to 6 inches apart. Some growers thin the clusters so that no two apples are borne on the same fruit spur.

Condition of crop and variety of apple are the most important factors influencing thinning. Some varieties, like Winesap, require so much more thinning than others, such as the Arkansas Black, that a general average of time required per acre for thinning is of little practical significance in itself. Estimates were obtained from each grower as to the number of trees a man would thin per 10-hour day, and as to the percentage of his trees thinned. These estimates were checked up with his estimate of the average time spent thinning his orchard per year. The averages derived from these estimates are shown in Table XV.

TABLE XV.—*Thinning practices and costs (125 ranches, western Colorado).*

County.	Number of records.	Number of records of thinning.	Per cent practicing thinning.	Number of trees per acre.	Average size of orchard (acres).	Trees thinned in 10 hours.	Per cent of trees thinned.	Distributed hours per acre.	Cost per acre.
Mesa	49	41	83.7	70	8.22	10.89	45.3	24.36	$6.09
Delta	61	45	73.8	78	12.19	16.45	44.1	15.42	3.86
Montrose	15	6	40.0	71	13.66	13.85	26.0	5.35	1.34
All counties	125	92	73.6	74	10.81	13.96	43.45	17.71	4.43

It will be seen from these figures that the more general the farm the less thinning is practiced. There is a decided drop in Montrose County, where orchards as compared to those of Mesa are not given a great deal of care. It is significant that the greatest proportion of cull apples is found in Montrose. It will also be seen that the larger the orchard the less time is spent thinning per acre, which

goes to account for the fact that orchards of larger acreages on the farms studied seldom produce as large a percentage of extra fancy fruit as do those of smaller size.

PROPPING.

So few growers of western Colorado practice propping that this operation need not be discussed here as a regular orchard operation. All propping time is included in miscellaneous labor.

CODLING MOTH BANDS.

A practice more common in western Colorado than in any place else in the United States is that of banding the tree for codling moth. This is particularly true of Mesa County. These bands are made of old sacks or cloth of any description, but the most satisfactory band is burlap. A band is placed around the tree from 8 to 12 inches from the ground. This is done about the middle of June and the band may be taken off in the fall or left on the tree. A band will last for two years on the tree, and if taken in during the winter will last longer. These bands are "worked" every week, ten days, or two weeks, depending on the prevalence of moths and the importance the grower attaches to the practice. By working the bands is meant the practice of removing the bands at one end from the trees and killing the codling moth larva. The larvæ after coming from the apple seek a place to pupate and select the band as an ideal place. A few growers use for this purpose an old sack stuffed into the fork of the tree. This answers practically the same purpose as the band, although probably somewhat less effective.

The time required for working depends very largely on the number of worms found. Table XVI shows that the practice of banding is almost entirely confined to the Grand Valley, or Mesa County.

TABLE XVI.—*Time chargeable per acre for working codling moths.*

Item.	Mesa.	Delta.	Montrose.	All counties.
Number of records	49	61	15	125
Number using bands	33	7	.....	40
Percentage using bands	67.3	11.5	.....	32
Time chargeable per acre to put on bands (hour)	.77	.11	.....	.35
Number of times worked	6.5	5.7	.....	5.33
Time chargeable per acre for working bands (hours)	10.02	1.21	.....	4.52
Time to put on and workbands (hours)	10.78	1.31	.....	4.87
Cost per acre	$2.70	$0.33	.....	$1.22

SPRAYING.

Spraying is one of the more important orchard practices of western Colorado, and one which, owing to a number of factors involved, varies greatly in the different counties.

The codling moth, because of the long season and dry climate, is very hard to control, especially in Mesa County, where conditions for its rapid development are very favorable. In Delta County the altitude is high enough and the climate moist enough to render the moth much less troublesome; indeed, in some of the higher orchards of this county it is almost unknown. For this reason there is much less spraying in Delta than in Mesa County. In Montrose County none of the growers visited sprayed over three times for the moth, the cost for that district falling even below that of Delta.

Besides the codling moth sprays it is now the general practice, enforced by law, to make a lime-sulphur spray for San Jose scale. At the time these records were taken, however (1914), only a few men sprayed for scale. Thus the cost of spraying for the region has been very materially increased since the figures here presented were obtained.

Sprays are also occasionally made with tobacco extract for aphis.

CODLING MOTH SPRAYS.

In Mesa County the codling moth is impossible to control with present methods without several sprays. Considering all records, Mesa has an average of 5.28 sprays as against 3.16 for Delta County and 2.73 for Montrose County. The first lead-arsenate spray is called the calyx spray and is applied when about two-thirds of the petals have fallen or before the calyx closes. The next spray follows in about 10 days or 2 weeks. The dates of spraying always depend on the relative time of blooming, weather conditions, and the relative abundance of the moth. The grower uses his own judgment to a great degree as to when and how often these sprays should be applied, though he is guided to some extent by the inspection of the local association or county agent.

In each of the three counties spraying in the bearing orchards is done almost exclusively with a gasoline-power spray outfit. Thirty-seven of the 49 growers in Mesa own spray rigs, while 12 hire the spraying done. Of the 61 growers in Delta County 51 own and 10 hire. Of the 15 in Montrose all own except one, who hires.

The customary spray mixture for codling moth is arsenate of lead and water. Two kinds of lead arsenate are used, paste and dry. As over 90 per cent used the paste lead arsenate, this will be considered here as the general practice. In Mesa County the lead arsenate is mixed in the proportion of 8 pounds to 200 gallons of water. In Delta County the average is 8.02 pounds to 200 gallons, and in Montrose, 10.22 pounds to 200 gallons. The regular rate of spraying labor is $1 per hour for man, team, and rig. This figures the man labor at 25 cents per hour, the team and rig at 75 cents.

The usual spraying crew is 3 men and 2 horses, although many use 2 men and 2 horses. On the farms studied approximately 73.5 per cent use the 3–2 crew in Mesa County, 70.5 per cent in Delta, and 73.3 per cent in Montrose. In Mesa 20.4 per cent use the 2–2 crew, 19.6 per cent in Delta, and 6.7 per cent in Montrose. Of all other crews, which include 1–2 crews, 4–2 crews, etc., 2.04 per cent are found in Mesa, 9.93 per cent in Delta, and 20 per cent in Montrose. (See Table XVII.)

TABLE XVII.—*Spraying practices (125 ranches, western Colorado).*

Spray.	Mesa.					Delta.				
	Number.	Per cent.	Crew.			Number.	Per cent.	Crew.		
			3–2	2–2	All others.			3–2	2–2	All others.
Using lime-sulphur spray	20	41	15	4	1	4	7	4	.....	.....
First lead arsenate spray	49	100	36	10	3	61	100	43	12	6
Second lead arsenate spray	49	100	35	11	3	60	98	43	12	5
Third lead arsenate spray	49	100	36	10	3	45	74	33	10	2
Fourth lead arsenate spray	47	96	34	11	2	22	36	16	6	.....
Fifth lead arsenate spray	42	86	30	10	2	5	8	3	2	.....
Sixth lead arsenate spray	23	47	17	5	1	.....	.....	.....	.....	.....

Spray.	Montrose.					All counties.				
	Number.	Per cent.	Crew.			Number.	Per cent.	Crew.		
			3–2	2–2	All others.			3–2	2–2	All others.
Using lime-sulphur spray	3	20	3	.....	.....	27	21.6	22	4	8
First lead arsenite spray	15	100	11	1	3	125	100	90	23	12
Second lead arsenate spray	15	100	9	3	3	124	99.2	87	26	11
Third lead arsenate spray	11	73	5	3	3	105	84.6	74	23	8
Fourth lead arsenate spray	.....	.....	.....	.....	.....	69	55.2	50	17	2
Fifth lead arsenate spray	.....	.....	.....	.....	.....	47	37.6	33	12	2
Sixth lead arsenate spray	.....	.....	.....	.....	.....	23	18.4	17	5	1

Table XVII gives a general idea of the practice, while Tables XVIII and XIX give detailed data on the efficiency of the 3–2 crew as compared with the 2–2 crew, which is shown to be fully as efficient as the 3–2 crew. This is because ordinarily the third man of the 3–2 crew is a driver and does not handle an extra lead of hose. Thus there are usually only two leads of hose, whatever crew is used. Table XX summarizes the efficiency data for the 3–2 and 2–2 crews.

TABLE XVIII.—*Cost of operation for 3-men, 2-horse spraying crew.*

Spray.	Number of records.	Normal time.	Acres per day.	Gallons per acre.	Gallons per tree.	Labor cost per acre.	Material cost per acre.	Total cost per acre.
Lime and sulphur spray	22	6.8	4.4	358	5.1	$2.38	$8.23	$10.61
First lead arsenate spray	90	7.81	3.8	519	7.1	2.73	2.15	4.88
Second lead arsenate spray	87	7.62	3.9	462	6.3	2.67	1.91	4.58
Third lead arsenate spray	74	7.62	3.9	480	6.6	2.67	1.98	4.65
Fourth lead arsenate spray	50	7.83	3.8	514	7.1	2.74	2.05	4.79
Fifth lead arsenate spray	33	7.81	3.8	542	7.6	2.73	2.17	4.90
Sixth lead arsenate spray	17	7.98	3.8	585	8.4	2.79	2.34	5.13
All lead arsenate sprays	351	7.73	3.8	501	6.8	2.71	2.07	4.78

TABLE XIX.—*Cost of operation for 2-men, 2-horse spraying crew.*

Spray.	Number of records.	Normal time.	Acres per day.	Gallons per acre.	Gallons per tree.	Labor cost per acre.	Material cost per acre.	Total cost per acre.
Lime and sulphur spray	4	6.14	3.3	324	4.6	$2.46	$7.45	$9.91
First lead arsenate spray	23	6.21	3.2	550	7.4	2.48	2.27	4.75
Second lead arsenate spray	26	5.53	3.6	458	6.2	2.21	1.89	4.10
Third lead arsenate spray	23	5.60	3.6	446	6.0	2.24	1.84	4.08
Fourth lead arsenate spray	17	5.38	3.7	490	6.6	2.15	1.96	4.11
Fifth lead arsenate spray	12	5.27	3.8	531	7.2	2.11	2.12	4.23
Sixth lead arsenate spray	5	4.97	4.0	532	7.6	1.99	2.13	4.12
All lead arsenate sprays	106	5.61	3.6	491	6.6	2.24	2.03	4.27

TABLE XX.—*Summary of comparative efficiency data for spraying crews.*

Crew.	Number of sprays studied.	Normal time man-hours.	Acres per day.	Gallons per acre.	Gallons per tree.	Cost per acre.		
						Labor.	Material.	Total.
3–2	351	7.73	3.8	501	6.8	2.71	2.07	$4.78
2–2	106	5.61	3.6	491	6.6	2.24	2.03	4.27

LIME-SULPHUR SPRAY.

The lime and sulphur is applied during the dormant season, usually during February or March, and is applied primarily for the San Jose scale, and, as the growers express it, to "clean up the trees." As stated above, comparatively few growers were using this spray when the records here presented were obtained. The average solution used is 1 to 10; that is, 20 gallons of lime-sulphur and 200 gallons of water.

APHIS SPRAYS.

Another spray sometimes applied separately, but usually in conjunction with one of the lead arsenate sprays, is the aphis spray. In Mesa County on the farms studied there was no record of the use of

this spray on bearing apples. In Delta County 18 men used the aphis spray. Of these, 15 applied it in combination with a lead arsenate spray, while 3 made separate sprays. In Montrose County 4 men used the aphis spray as a separate spray. In either case the usual mixture was 1½ pints of tobacco extract to a 200-gallon tank. In Montrose 203.8 gallons per acre were applied as compared to 418 for the 3 separate aphis sprays of Delta County and 558 for the 15 combination sprays.

Table XXI summarizes all spraying costs, there being a total of $30.41 for Mesa, $16.68 for Delta, and $12.36 for Montrose. The high spraying cost in Mesa has already been explained. These costs are all figured on the same man-hour and horse-hour rate basis used in figuring other orchard operations. The few who hired their spraying done were charged at the regular rate. The upkeep and depreciation of the spray rig is an important item which will be taken up under discussion of equipment and machinery depreciation.

TABLE XXI.—*Summary of costs for all sprays (125 ranches, western Colorado).*

Item.	Mesa.	Delta.	Montrose.	All counties.
Man-hours	40.83	24.71	18.54	30.29
Horse-hours	29.2	18.21	12.77	21.87
Cost per acre:				
Labor	$14.59	$8.91	$6.55	$10.85
Material	15.82	7.77	5.81	10.68
Total	30.41	16.68	12.36	21.53
Cost per box:				
Labor	.053	.030	.024	.0382
Material	.058	.026	.021	.0376
Total	.111	.056	.045	.0758

SCRAPING TREES.

An operation of important bearing upon the health of the tree is the scraping of the loose bark from the trunk and lower limbs of the tree. This is done usually during the winter or early spring to remove codling-moth larvæ or other insects which may be underneath the loose bark. A sharp hoe is generally used for the purpose. This practice is followed principally in the Grand Valley, where 30 growers of the 49, or 61.2 per cent, scrape their trees, some every year and others every 2 years. In Delta County only 4 practice scraping, and in Montrose none. On the farms studied the average number of trees that a man will scrape in 10 hours in the Grand Valley is 45; in Delta, according to the 4 records taken, 53. The time chargeable per acre, 3.45 hours in Mesa and 0.86 hour in Delta, has been counted under miscellaneous labor.

MISCELLANEOUS LABOR.

All major orchard operations prior to harvesting time have been discussed, but their remain many minor items of labor which in the aggregate have considerable weight. These items, in order of importance are cleaning laterals and waste ditches (including mowing weeds along the ditches) (see fig. 9); propping; summer pruning or water sprouting; cleaning up the packing shed; hoeing weeds; mowing weeds or mulch crop to leave on the ground as a mulch; sowing mulch crops, and other occasional items. These odd costs were com-

FIG. 9.—Cleaning a waste ditch in the Grand Valley district. This operation is necessary at least once a year and is one of the principal items of miscellaneous labor.

bined and the time distributed over the total number of records for each county. (See Table XXII.)

TABLE XXII.—*Miscellaneous labor (125 ranches, western Colorado).*

Item.	Mesa.	Delta.	Montrose.	All counties.
Man-hours, per acre	12.35	9.58	11.5	10.90
Horse-hours, per acre	.71	3.33	7.8	2.84
Cost per acre	$3.20	$2.89	$4.05	$3.14
Cost per box	$0.012	$0.010	$0.015	$0.011

ORCHARD HEATING.

Orchard heating or smudging, as it is generally termed by growers in this region, has for several years been very much out of favor in western Colorado. There are now few men left who have the equipment to smudge and still fewer who believe in it. It is still practiced in the Palisade peach district. In the spring of 1915, when

severe frosts occurred in early May, only a very few apple growers in the entire Grand Valley set out their smudge pots and saved their crops. There is no doubt that orchard heating paid that year. This was due largely to weather conditions, the night being so still that the smoke hung in thick clouds over the orchards. Such results, however, are exceptional. In the early years of the fruit industry orchard heating was a universal practice, but owing to the great expense of equipment and operation, and to frequent failure to save the crop owing to adverse weather conditions, the practice has been almost wholly discontinued. (See fig. 10.) Over 90 per cent of Mesa growers interviewed, while admitting that smudging some-

FIG. 10.—Discarded smudge pots on a ranch near Grand Junction. Smudging is now practiced by very few growers.

times saves the crop, maintain that as an insurance it is too expensive. There are a few men, however, who have followed the practice regularly and never lost faith in it. Some of these men are among the most successful men in the valley, but their numbers are so few and their costs and methods so various that no accurate average costs for smudging could be obtained. The apple growers on the farms studied in the lower sections of Delta County formerly practiced orchard heating, as did all those of Montrose, where many still put out their smudge pots every year.

In the discussion of cost production no figures for orchard heating are taken into account, since not enough estimates could be obtained to constitute reliable data.

HARVESTING OPERATIONS.

Under harvesting operations are included all those items pertaining to the harvesting of the crop from the time the apples are picked until they are delivered at the station or warehouse. These operations include hauling the box shooks, making the boxes, hauling the empty boxes to the orchard and the full ones to the packing shed, picking, grading, sorting, packing, nailing, and stamping, waiting, and all other packing-house labor, and, lastly, hauling the boxes to the loading station. These operations will be discussed under three general headings, viz, hauling, picking, and packing-house time and costs.

HAULING.

HAULING BOX SHOOKS.

In hauling the box shooks all the growers on the farms studied hauled with a 1-man, 2-horse crew. The average distance hauled for the three counties was 3.11 miles, with a cost of $0.0047 per box, the average load 402 boxes. Table XXIII shows the relative cost for the farms studied in the three counties.

TABLE XXIII.—*Hauling shooks (1–2 crew).*

County and number of records.	Man-hours per acre.	Horse-hours per acre.	Boxes per load.	Number miles.	Boxes per hour per mile.	Cost per box per mile.	Cost per acre.	Cost per box average distance hauled.
Mesa, 49	1.87	3.73	428	3.03	446.8	$0.00123	$1.03	$0.00373
Delta, 61	2.77	5.55	383	3.13	330.5	.00166	1.53	.00519
Montrose, 15	2.94	5.87	400	3.3	305.4	.00180	1.62	.00594
All counties, 125	2.44	4.87	402.68	3.11	373.08	.00151	1.34	.00471

HAULING FULL BOXES TO CAR.

As in hauling shooks, the ordinary crew used in hauling to the station is the 1-man, 2-horse crew. The average for the three counties is 73.5 boxes per load; distance, 2.45 miles; cost of 1 cent per box per mile, or $0.0249 per box for the average distance hauled. As will be seen from Table XXIV, the cost per box per mile varies but little.

TABLE XXIV.—*Hauling full boxes to car (1–2 crew).*

County and number of records.	Man-hours per acre.	Horse-hours per acre.	Boxes per load.	Number miles.	Boxes per hour per mile.	Cost per box per mile.	Cost per acre.	Cost per box average distance hauled.
Mesa, 49	9.87	19.74	76	2.1	58.53	$0.00940	$5.43	$0.01974
Delta, 61	15.10	30.20	71	2.53	49.20	.01117	8.31	.02826
Montrose, 15	14.04	28.08	76	3.3	64	.00860	7.72	.02838
All counties, 125	12.92	25.85	73	2.45	54.63	.01017	7.11	.02493

HAULING TO ORCHARD AND BACK TO PACKING SHED.

In hauling to and from the orchard it is the usual practice to haul the empty boxes out and distribute them as needed and haul full ones in on the same truck or sled. In nearly 80 per cent of the records a truck is used for this purpose. The 1–2 crew is the most common. For the smaller orchards the hauling is often done by the owner, who may also nail up the boxes or do other work about the packing house. The average load of full boxes drawn is 38 with the 1–2 crew and 20 with the 1–1 crew. In hauling out the empties the size of the load is about double the number of full boxes hauled in. Tables XXV and XXVI cover both hauling out and in. The costs per box are for packed boxes—not loose boxes as they are hauled from the orchard. The estimates in most cases were that 3 loose boxes would make 2 packed boxes and the costs are figured in that basis. Table XXVII serves to show how the counties compare in practice and time and cost per box, regardless of the method used.

TABLE XXV.—*Hauling to and from packing shed (1–2 crew).*

County and number of records.	Yield per acre, packed boxes.	Yield per acre, loose boxes.	Man-hours per acre.	Horse-hours per acre.	Boxes per load.	Boxes in 10 hours.	Cost per acre.	Cost per box.
Mesa, 41	275	413	6.36	12.73	33	649	$3.50	$0.0127
Delta, 58	294	441	9.82	19.64	40	449	5.40	.0184
Montrose, 15	272	408	10.12	20.24	42	403	5.57	.0205
All counties, 114	284	426	8.62	17.23	38	515	4.74	.01662

TABLE XXVI.—*Hauling to and from packing shed (1–1 crew).*

County and number of records.	Yield per acre, packed boxes.	Yield per acre, loose boxes.	Man-hours per acre.	Horse-hours per acre.	Boxes per load.	Boxes in 10 hours.	Cost per acre.	Cost per box.
Mesa, 8	275	413	8.43	8.43	20	490	$3.37	$0.01226
Delta, 3	294	441	16.52	16.52	21	267	6.60	.02244
Montrose, 0	272	408	.....	.....	.....	.....	.....	.....
All counties, 11	284	426	10.64	10.64	20	429	4.25	.01504

The average distance hauled is less than in hauling shooks, for in hauling the full boxes they are hauled usually to the nearest railroad siding, while shooks are more often hauled from the main railroad station. Some growers haul part of their shooks back with them after they have taken a load of full boxes to the car, but the average time and costs are figured on the practice of the great majority of growers.

A few growers, particularly in Paonia, haul the loose boxes to the association warehouse, where they are packed at a fixed cost per box. However, none of the growers considered in these records follow this practice.

TABLE XXVII.—*Hauling to and from packing shed (125 records, western Colorado).*

County.	Man-hours per acre.	Horse-hours per acre.	Cost per acre.	Cost per box.
Mesa, 49	6.70	12.02	$3.48	$0.0127
Delta, 61	10.16	19.48	5.46	.0185
Montrose, 15	10.12	20.24	5.57	.0205
All counties, 125	8.79	16.65	4.70	.0165

PICKING.

Picking is one of the more expensive operations connected with the apple-growing industry. The season of picking rarely begins on standard varieties before September 1 and lasts not later than November 10. Of the standard varieties, such varieties as Jonathan and Grimes are among the first picked and Ben Davis and Gano are among the last. Generally speaking, the apples are picked approximately in order of their keeping quality.

Picking sacks opening from the bottom are generally used, the apples being transferred from the sack to the loose boxes in which they are hauled to the packing shed. Step ladders of various lengths are used. Many of the apples are reached from the ground; indeed only in the older orchards is it necessary to climb about the trees.

The picking is done almost exclusively with day labor, in which case it costs over 6 cents per packed box to pick the fruit. Pickers are sometimes hired by the box at 5 cents per box, but in the opinion of the average grower this practice does not pay, since any advantage gained is more than offset by loss entailed by careless picking. Table XXVIII shows picking costs by counties. The cost per box varies from $0.061 in Mesa to $0.072 in Montrose.

MAKING BOXES.

The grower usually makes boxes during spare time, averaging 200 to 300 per day. When made by hired help working by the piece, the usual rate is 1 cent per box.

TABLE XXVIII.—*Picking costs in the different counties (125 ranches, western Colorado).*

County.	Loose boxes in 10 hours.	Packed boxes in 10 hours.	Hours per acre.	Cost per per acre.	Boxes per acre.	Cost per box.
Mesa, 49	61.43	40.95	67.15	$16.79	275	$0.06140
Delta, 61	56.28	37.52	78.35	19.59	294	.06662
Montrose, 15	52.33	34.88	78.27	19.57	272	.07194
All counties, 125	57.82	38.55	73.95	18.49	284	.06510

PACKING COSTS.

The largest item of labor connected with the harvesting of the apple crop is the packing-house cost, which includes the cost of sorting, packing, nailing, waiting, and all other packing-house labor, including the wages of a packing boss where one is used.

As will be seen from Table XXIX, there is a very wide variation in methods used. In Mesa County sizers are in common use. In most instances these are merely hand sizers, and one man sizes the apples and nails for the packers, though in some cases the labor is distributed differently, according to the size of the packing crew. In large crews it takes one man's time to wait on the packers and one man's time to nail.

TABLE XXIX.—*Packing-house practices.*

County.	Pack.		Sort and pack.		Nail and wait.		Grade and nail.		Grade.		Hand sort.		Nail.	
	Number of records.	Boxes in 10 hours.	Number of records.	Boxes in 10 hours.	Number of records.	Boxes in 10 hours.	Number of records.	Boxes in 10 hours.	Number of records.	Boxes in 10 hours.	Number of records.	Boxes in 10 hours.	Number of records.	Boxes in 10 hours.
Mesa	38	58	11	51	16	179	31	174	3	212	4	100	2	300
Delta	4	57	57	39	18	173	1	180	1	250	2	153	42	370
Montrose	2	47	13	41	1	100	0	0	1	177	1	125	14	278
Counties	44	57	81	41	35	174	32	174	5	212	7	79	58	345

In the figures for hand sorting, those for the separate counties are given in loose boxes, while for the entire region they are given in packed boxes. In figuring the cost per box, as shown in Table XXX, an average cost is arrived at for each operation, using the percentage of the 125 growers who practiced each operation, the average number of boxes which constitutes a day's work, and a labor rate of $2.50 per day (the labor rate used in calculating all packing-house operations). In actual practice, packing is largely piecework, paid for at the rate of from 4 to 6 cents per box, depending on the pack, the size of fruit, and the scarcity or abundance of help. In order to make the figures comparable, for many of the small growers do their own packing with the aid of their wives and children, the regular day rate for other packing-house labor is used, the result being practically the same as when the rate for piecework is used. The miscellaneous column includes all waiting not connected with nailing or other regular operations, trucking, overseeing, and any incidental labor about the packing house. In the farms studied the packing-house labor charge is found to be $0.068 per box in Mesa, $0.073 per box in Delta, and $0.079 per box in Montrose, or $0.072 per box as an average for the region.

TABLE XXX.—*Packing-house charge.*

Operation.	Mesa (average yield, 275).			Delta (average yield, 294).			Montrose (average yield, 272).		
	Per cent of records.	Cost per box.[1]		Per cent of records.	Cost per box.		Per cent of records.	Cost per box.	
		Actual.	Regional.		Actual.	Regional.		Actual.	Regional.
Pack	77.5	$0.0440	$0.0341	6.6	$0.0440	$0.0029	13.3	$0.0440	$0.0059
Sort and pack	22.4	.0610	.0137	93.4	.0610	.0570	86.7	.0610	.0529
Nail and wait	32.6	.0144	.0047	29.5	.0144	.0042	6.7	.0144	.0010
Nail	4.1	.0072	.0003	68.9	.0072	.0050	93.3	.0072	.0067
Grade and nail	63.3	.0144	.0091	1.6	.0144	.0002			
Grade	6.1	.0118	.0007	1.6	.0118	.0002	6.7	.0118	.0008
Sort	8.2	.0316	.0026	3.3	.0316	.0010	6.7	.0316	.0021
Wait and miscellaneous	100	.0030	.0030	100	.0029	.0029	100	.0096	.0096
Cost per box			.068			.073			0.079
Cost per acre			$18.76			$21.59			$21.46
Hours per acre			75.04			86.37			85.84

[1] "Actual" cost is the cost for growers reporting. "Regional" cost is the actual cost distributed over all records.

The totals of all labor costs are summarized in Table XXXI. The cost per box varies from $0.37 in Delta to $0.42 in Mesa, the average being $0.394. The labor cost per acre on all records is $111.88. There is considerable variation in cost on such items as spraying and thinning, etc., owing to the difference in the intensiveness of the farming carried on in the three counties.

TABLE XXXI.—*Summary of all labor costs (125 ranches, western Colorado).*

Item.	Mesa (49 records, 275 yield.				Delta (61 records, 294 yield).			
	Man-hours.	Horse-hours.	Cost per acre.	Cost per box.	Man-hours.	Horse-hours.	Cost per acre.	Cost per box.
Manure	3.71	7.42	$2.04	$0.007	5.03	9.10	$2.62	$0.009
Prune	62.61		21.91	.080	47.73		16.71	.057
Haul brush	9.75	12.84	4.36	.016	8.46	9.90	3.60	.012
Thin	24.36		6.09	.022	15.42		3.86	.013
Cultivate	18.55	35.63	9.98	.036	14.08	28.14	7.74	.026
Irrigate	11.59		2.90	.011	15.66		3.91	.013
Spray	40.83	29.2	14.59	.053	24.71	18.21	8.91	.030
Codling-moth bands	10.78		2.70	.010	1.31		.33	.001
Miscellaneous	12.35	.71	3.20	.012	9.58	3.33	2.89	.010
Haul shooks	1.87	3.73	1.03	.004	2.77	5.55	1.53	.005
Haul to and from orchard	6.70	12.02	3.48	.013	10.16	19.48	5.46	.019
Haul to car	9.87	19.74	5.43	.020	15.10	30.20	8.31	.028
Pick	67.15		16.79	.061	78.35		19.59	.067
Pack, nail, grade	75.04		18.76	.068	86.38		21.59	.073
Make boxes	11.00		2.75	.010	11.76		2.94	.010
Total	366.16	121.29	$116.01	$0.423	346.50	123.91	$109.99	$0.373

TABLE XXXI.—*Summary of all labor costs (125 ranches, western Colorado)*—Contd.

Item.	Montrose (15 records, 272 yield).				All records (125, 284 yield).			
	Man-hours.	Horse-hours.	Cost per acre.	Cost per box.	Man-hours.	Horse-hours.	Cost per acre.	Cost per box.
Manure	7.77	15.55	$4.28	$0.016	4.84	9.21	$2.59	$0.009
Prune	48.59	.....	17.01	.063	53.66	.....	18.78	.066
Haul brush	6.43	7.78	2.77	.010	8.72	10.64	3.78	.013
Thin	5.35	.....	1.34	.005	17.71	.....	4.43	.016
Cultivate	15.25	30.50	8.39	.031	15.97	31.36	8.70	.031
Irrigate	12.99	.....	3.25	.012	13.74	.....	3.44	.012
Spray	18.54	12.77	6.55	.024	30.29	21.87	10.85	.038
Coddling-moth bands	.....	.....	.....	.....	4.87	.....	1.22	.004
Miscellaneous	11.50	7.80	4.05	.015	10.90	2.84	3.14	.011
Haul shooks	2.94	5.87	1.62	.006	2.44	4.87	1.34	.005
Haul to and from orchard	10.12	20.24	5.57	.021	8.79	16.65	4.70	.017
Haul to car	14.04	28.08	7.72	.028	12.92	25.85	7.11	.025
Pick	78.27	.....	19.57	.072	73.95	.....	18.49	.065
Pack, nail, grade	85.84	.....	21.46	.079	81.87	.....	20.47	.072
Make boxes	10.85	.....	2.72	.010	11.36	.....	2.84	.010
Total	328.48	128.59	$106.30	$0.392	352.03	123.29	$111.88	$0.394

It should be borne in mind that this table is for labor only, including no material of any kind, and that it represents but about 50 per cent of the cost of delivering a box of apples f. o. b. at the shipping station.

YIELDS.

In determining average yields, figures were obtained for five years, where possible, and an average taken by age of trees, thus scattering light yields occasioned by frost. This method gives a fairer figure than could be obtained by taking the average by years, since in that case the light yields would be bunched. (See Table XXXII.)

Averages were taken from the ages of 13 to 18 years, inclusive. On the farms studied it was found that in Mesa County the average yield for full-bearing trees 13 to 18 years old was 275 packed boxes or 3.9 boxes per tree. On those in Delta County there was an average yield on the same age trees of 294 boxes per acre or 3.8 boxes per tree, and in Montrose County there was an average of 272 boxes, or 3.8 boxes per tree.

TABLE XXXII.—*Average yield per acre and per tree (125 ranches, western Colorado).*

County.	Yield per acre.	Yield per tree.	Number of estimates of different ages.						
			13 years.	14 years.	15 years.	16 years.	17 years.	18 years.	13 to 18 years inclusive.
Mesa	275	3.9	22	23	26	20	21	14	126
Delta	294	3.8	40	33	31	31	27	13	175
Montrose	272	3.8	11	10	9	6	6	2	44
All counties	284	3.8	73	66	66	57	54	29	345

In arriving at these averages the same weight is given each age, regardless of the number of estimates, thus avoiding weighted averages. In getting a yield for the three counties, however, an average is figured on the basis of the 125 records as though there were no division in counties, thus giving each record its proper weight in the grand average of all records.

On the farms studied it was found that the average yield for all apple orchards between the ages of 13 and 18 years was 284 boxes per acre, or 3.8 boxes per tree. The uniformity of the yield in the three different counties shows that these figures present a fairly accurate average. The yield is only for packed boxes of marketable fruit. To express the yield in terms of loose boxes, one-half must be added to this average. Packing-house managers and growers agree that on an average three loose boxes pack out two packed boxes.

If the average yield for each individual record is taken regardless of age of trees, the average of all orchards is 278 boxes per acre.

In order to determine the influence of the size of orchard on yield, 104 individual records of fairly uniform ages were used. Of these, 35 were over 10 acres in size., 47 were between 6 and 10 acres, inclusive and 22 were 5 acres and under.

TABLE XXXIII.—*Relation of size of orchard to yield.*

Size orchard.	Number of orchards.	Yield per acre (boxes).
Over 10 acres	35	230
6 to 10 acres, inclusive	47	285
1 to 5 acres, inclusive	22	316

It is apparent from Table XXXIII that size of orchard has a direct bearing on the yield per acre. The number of trees per acre remained practically constant. The large yields per acre on the small orchards may be accounted for, in part, by the better care which they receive, since a grower naturally can attend to more details with a five-acre orchard than with one of twenty.

The different systems of orchard management as regards the use of mulch crops and clean cultivation made no appreciable difference in the yields. However, a comparison by this method would not be fair in this connection, since mulch crops have not been in use long enough to affect the average yield when these records were taken. It may be said that the use of mulch crops apparently has not decreased the yield, while continued intensive clean cultivation with no addition of humus has decreased it. Orchards regularly manured showed a yield

much above the average. Systematic thinning also increases the yield of marketable fruit.

The drop or cull apples are not counted in the yields. Generally speaking, these are as yet practically waste in Colorado. A few are hauled to vinegar factories, some are made into cider, some fed to stock, but the great bulk of cull fruit is not marketed in any way and thus can not be credited to the orchard. By systematic thinning, spraying, etc., this unmarketable fruit is reduced to a minimum; indeed is almost entirely eliminated by a few of the more careful growers.

MARKETING.

The apples are marketed usually in three grades, namely, "Extra fancy," "Fancy," and "Choice" or "C" grade. In Montrose County, however, there is a tendency to make a jumble pack.

At the time of this study the fruit was marketed largely through selling organizations, cooperative and otherwise. The growers contract with these organizations and agree to allow them to handle their fruit, either at a fixed cost per box or on commission. The usual custom with cooperative selling organizations has been to handle the fruit at a cost of 10 cents per box. Growers often market their own fruit, but to do this they have to follow it up, and serious difficulties are often encountered.

MATERIALS AND FIXED COSTS.

The expenses other than labor may be grouped into "fixed costs" and material costs. (See Table XXXIV.) The fixed costs include taxes, water rent, insurance, interest, and depreciation, while the material costs include boxes, nails, paper, labels, lime-sulphur, lead arsenate, and all other spray materials. There is also the cost or value of manure charged to the orchard, which is a material cost. Included among cash costs is the spray rig hire. This refers only to the rig itself, as all man and horse labor is charged elsewhere. It is necessary for this cost to appear, since 24.5 per cent of the men in Mesa, 16.4 per cent in Delta, and 6.6 per cent in Montrose hire spraying done, and the cost of the spraying equipment is not charged in the depreciation charges which appear. Therefore, the cost of hiring these rigs at 45 cents per hour for the use of the rig alone is distributed over all the records.

TABLE XXXIV.—*Material and fixed costs (125 ranches, western Colorado).*

Item.	Mesa (275).		Delta (294).		Montrose (272).		All counties (284).	
	Cost per acre.	Cost per box.	Cost per acre.	Cost per box.	Cost per acre.	Cost per box.	Cost per acre.	Cost per box.
Box shook, at 12½ cents	$34.38	$0.1250	$36.75	$0.1250	$34.00	$0.1250	$35.50	$0.1250
Nails	1.10	.0040	1.18	.0040	1.09	.0040	1.14	.0040
Paper	1.10	.0040	2.03	.0069	1.77	.0065	1.63	.0058
Labels	1.37	.0050	1.47	.0050	1.36	.0050	1.42	.0050
Lime sulphur, at 23 cents per gallon	3.80	.0138	.24	.0008	1.20	.0044	1.75	.0062
Tobacco extract, at $1.56 per pint	.....	.....	1.84	.0063	.63	.0023	.97	.0034
Lead arsenate, at 10 cents per pound	12.02	.0437	5.68	.0193	3.98	.0146	7.96	.0280
Manure, at $1.50 per ton	3.57	.0129	6.38	.0217	6.35	.0233	5.27	.0185
Gasolene, at 20 cents per gallon	.91	.0033	.57	.0019	.40	.0015	.68	.0024
Cash machine hire	1.61	.0059	.67	.0023	.19	.0007	.98	.0035
Taxes	5.23	.0190	3.30	.0112	2.56	.0094	3.97	.0140
Water rent	1.95	.0070	1.84	.0063	1.33	.0049	1.82	.0064
Insurance	.83	.0030	.42	.0014	.36	.0013	.57	.0020
Interest	60.13	.2187	50.21	.1708	35.14	.1292	52.29	.1841
Depreciation and upkeep of equipment	9.01	.0328	5.99	.0204	7.79	.0286	7.39	.0260
Packing-house annual upkeep	3.75	.0136	5.40	.0184	3.90	.0143	4.57	.0161
Total	140.76	.512	123.97	.422	102.05	.375	127.91	.450

The depreciation on equipment, together with the upkeep and interest on the equipment, was arrived at by estimates of growers on the length of life of the equipment, which varies according to the tool used and whether it is housed or not. The equipment charge per acre of apple orchard is figured in the following way:

	Per cent.
Interest	8
Depreciation	11
Taxes	1
Repairs	5
Annual charge	25

In order to get a comparable figure for the equipment investment per acre of bearing apples, the following method was used:

Value of apple orchard per farm divided by land and improvement investment per farm equals percentage of value of land investment which apple orchard represents. This percentage multiplied by equipment investment per farm equals equipment investment per orchard.

Equipment investment per orchard multiplied by 25 per cent equals annual equipment charge per orchard.

Annual equipment charge per orchard divided by average size orchard equals annual equipment charge per acre.

On most of the ranches studied there is some building erected especially for apples. This may be either a packing shed or cellar for temporary storage. A few growers have expensive packing houses, but the majority are simple frame structures erected at a small cost. In many cases these sheds are a part of the barn, and may be used

for other purposes, in which case only the proportionate share of the value is charged to the orchard. The investments in such buildings range from $25 to $3,000, but very few have packing houses or cellars costing $1,000 or over. It was found that the growers of Mesa have an investment of $25 per acre for buildings of this kind; those of Delta, $36 per acre, and those of Montrose, $26 per acre. The annual charge on these apple buildings is, according to estimates, 15 per cent, divided about as follows:

	Per cent.
Interest	8
Depreciation	3
Repairs	3
Taxes	1
Total	15

There is, then, an annual charge of $3.75 per acre in Mesa, $5.40 per acre in Delta, and $3.90 per acre in Montrose for buildings or cellars directly connected with handling the apples.

In figuring cash or material costs, the following factors are considered:

Box shooks, ready to be made up, at 12½ cents.

Nails, at $4 per keg (5d). Allow one keg to 1,000 boxes, or $0.004 per box.

Paper:

Mesa County—50 pounds of sides, at 7½ cents pound per 950 boxes, or $0.004 per box.

Delta County—64 pounds of sides, at 7 cents, and 34 pounds of ends at 7 cents, for 1,000 boxes, or $0.0069 per box.

Montrose County—60 pounds of sides at 7 cents, and 32½ pounds of ends at 7 cents, for 1,000 boxes, or $0.0065 per box.

Labels put on by the association at one-half cent per box or by owners at one-third cent and labor of applying.

Lime sulphur (1–10 solution used) at $11.50 per barrel, or 23 cents per gallon.

Tobacco extract at $12.50 per gallon, or $1.56 per pint, used 1½ pints to 200 gallons of water.

Paste form arsenate of lead generally used; 8 pounds in Mesa, 8.02 pounds in Delta, and 10.22 pounds in Montrose to 200 gallons of water. Average cost per pound, $0.10.

Manure, 2.38 tons per acre in Mesa, 4.25 tons in Delta, and 4.23 tons in Montrose, at $1.50 per ton.

Gasoline, average 1 pint per horsepower per hour; spray rigs average 2½ horsepower; 14.6 engine-hours in Mesa, 9.11 in Delta, and 6.39 in Montrose, or 4.56 gallons in Mesa, 2.85 gallons in Delta, and 1.99 gallons in Montrose, at 20 cents per gallon.

Spray rig hire: Figures for the use of rig alone, at 45 cents per hour, using average engine-hours per acre for each county and distributing over all records.

Water tax figured from average annual rent or cost of maintenance per acre.

Taxes: Percentage total investment bearing orchard represents multiplied by taxes per farm divided by average size orchard equals tax per acre.

Insurance: Percentage total investment bearing orchard represents multiplied by insurance divided by average size orchard equals insurance per acre.

Equipment charge fully explained above.

Packing house: 15 per cent annual charge for interest, upkeep, depreciation, etc.

Interest: Value of apple orchard per acre multiplied by 8 per cent interest.

SUMMARY OF ALL COSTS.

In Table XXXV is given a summary of all costs, including every item of expense chargeable to the orchards on all records.[1]

TABLE XXXV.—*Summary of all costs.*

Item.	Mesa.	Delta.	Montrose.	All counties.
Total labor cost per acre	$116.01	$109.99	$106.30	$111.88
Total material and fixed cost per acre	140.76	123.97	102.05	127.91
Total all costs per acre	256.77	233.96	208.35	239.79
Total labor cost per box	.423	.373	.392	.394
Total material and fixed cost per box	.512	.422	.375	.450
Total all costs per box	.935	.795	.767	.844

This, it should be borne in mind, is the average cost of all records figured on the acre basis and giving all an equal weight. Care was taken to include every item, and the figures obtained may be considered as fairly accurate averages for the region. The comparatively high cost in Mesa County is due primarily to the more intensive system practiced there and to the fact that the investment per acre in bearing orchard is considerably greater in Mesa than in the other counties. The cost, therefore, of producing a box of apples in the Grand Valley is greater on the average than in Delta or Montrose Counties. When all of the 125 records are considered it was found that the cost was $0.844 per box, which, for all practical purposes, may be said to be the average annual cost per box of producing apples in western Colorado.

[1] No account is taken of smudging, which is not a regular practice, nor of credit for the mulch crop taken off as hay, which credit at the time the records were taken would about balance the cost of taking it off, which was not a practice.

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